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### (54) Surface treating of polyphenylene ether thermoplastic shaped articles

Oberflächenbehandlung eines geformten thermoplastischen Polyphenylenäthergegenstandes

Traitement de surface en articles moulés en polyphénylène-éther thermoplastique

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(73) Proprietor: SUMITOMO CHEMICAL COMPANY,  
LIMITED  
Osaka-shi, Osaka (JP)

(72) Inventors:

- Abe, Hiroomi  
Chiba-shi, Chiba (JP)
- Shinonaga, Hideo  
Chiba-shi, Chiba (JP)
- Kitadono, Kaoru  
Ichihara-shi, Chiba (JP)

- Suzuki, Yasuro  
Kisarazu-shi, Chiba (JP)
- Sogabe, Satoru  
Kimitsu-gun, Chiba (JP)

(74) Representative: Dixon, Donald Cossar et al  
Gee & Co.  
Chancery House  
Chancery Lane  
London WC2A 1QU (GB)

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## Description

The present invention relates to a method of surface treating a thermoplastic resin shaped article containing a polyphenylene ether and at least one thermoplastic resin selected from polyamides and saturated polyesters, and also relates to a method of coating such shaped article.

A polyphenylene ether resin is a thermoplastic polymer having excellent properties such as mechanical properties, heat resistance, cold resistance and dimensional stability. However, the polyphenylene ether alone has very poor impact resistance and solvent resistance and also poor processability because of its high melt viscosity. On the other hand, polyamide resins and saturated polyester resins are thermoplastic polymers which are excellent in mechanical strength, solvent resistance and processability, but they have insufficient impact resistance and heat resistance and also have extremely poor dimensional stability due to high water absorption thereof. In order to take advantage of the desirable properties of (a) the polyphenylene ether resin and (b) the polyamide or saturated polyester resin and to overcome their respective defects, it has been proposed to blend the resins. However, since simple blending alone impairs the good mechanical properties possessed by both resins, it is customary to use various compatibilizers at the time of blending the resin (a) and (b) so as to improve their dispersibility, thereby to attain improved mechanical properties. Such techniques are disclosed, for example, in JP-B-60-11966, JP-B-61-10494, JP-A-59-66452 and JP-A-56-49753. ("JP-B" and "JP-A" denote an examined Japanese patent publication and an unexamined published Japanese patent application, respectively.) The thus-obtained compositions of resins (a) and (b) are being used as materials having excellent mechanical properties, heat resistance, solvent resistance, processability, dimensional stability and hygroscopicity, for application in the fields of electrical or electronic appliances, automotive parts such as external automotive plates, parts located around the engine, and wheel covers.

Among such uses, external automotive plates in particular are an application in which coating is requisite.

In a conventional coating method, a shaped part obtained by shaping the above-described material is pretreated, e.g. with isopropyl alcohol, subsequently an interlayer called a primer is applied on the pretreated surface, and then a coating is applied. Such a coating method has a problem that it necessitates a long manufacturing coating line, causing the cost of a final product to be high. The high cost of a final product is also attributable to expensiveness of the primer itself. Hence, improvements are desired.

Other surface treatments for coating which have been proposed include sandblasting, treatment with a chromic acid mixture, flame treatment, corona discharge treatment, and plasma treatment, but satisfactory results have not been obtained with any of these conventional treatments. It is therefore desirable to devise a new method of treatment.

EP-A-0466930 discloses a method of improving the surface characteristics of a molded article made from a composition comprising a thermoplastic resin and a functionalised polyolefin resin. In addition, EP-A-0465664, EP-A-0471078 and EP-A-0471079, which are all state of the art in accordance with Article 54(3) EPC, disclose surface treatment of various thermoplastic resins.

Further, EP-A-0430545 discloses surface irradiation of articles molded from polypropylene compositions. WPI Abstracts of JP-A-60245643, JP-A-58098340 and JP-A-1075078 disclose surface treatment by UV irradiation of synthetic resin molding, polyolefin resin molding and polyolefin molded products respectively. In addition, US-A-4287496 discloses a method for improving the surface of plastic materials by stretching at least in one direction during or after irradiation with UV light.

An object of the present invention is to provide a method of surface treating a shaped article of a composition comprising a polyphenylene ether resin and at least one thermoplastic resin selected from a polyamide and a saturated polyester, to attain excellent coating suitability and to eliminate the above described conventional problems.

Another object of the present invention is to provide a method of coating such a shaped article.

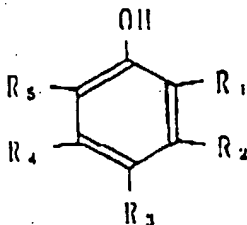
We have now found that surface characteristics of the above-described thermoplastic resin shaped article having well-balanced physical properties and a uniform and smooth appearance can be markedly improved by irradiating a surface of the shaped article with an ultraviolet light whose main wavelength is present in a region of 300 nm or less.

That is, the present invention relates to a method of surface treating a shaped article made of a thermoplastic resin, which comprises irradiating a surface of the shaped article with ultraviolet light having a wavelength of 300 nm or less, said shaped article being obtained from a resin composition comprising by weight, (I) from 5 to 100% of a polyphenylene ether, a mixture of a polyphenylene ether and a styrene polymer, or a graft copolymer of a polyphenylene ether and styrene and from 95 to 0% of at least one polyamide and/or saturated polyester, and per 100 parts by weight of composition (I); a rubbery substance (II) in an amount of up to 50 parts; (III) 0 to 5 parts of an inorganic filler and/or glass fibers; and at least one compatibilizer (IV) in an amount of up to 10 parts, said compatibilizer selected from maleic anhydride, maleic acid, fumaric acid, itaconic acid, glycidyl acrylate, glycidyl methacrylate and allyl glycidyl ether, and said rubbery substance (II) being one or more polymers selected from ethylene-propylene rubbers, ethylene-propylene-non-conjugated diene rubbers, styrene-butadiene block copolymers, partially hydrogenated styrene-butadiene block copolymers, styrene-isoprene block copolymers, partially hydrogenated styrene-isoprene block copolymers, styrene-grafted ethylene-propylene rubbers, styrene-acrylonitrile-grafted ethylene-propylene rubbers, styrene-grafted ethylene-

propylene-non-conjugated diene rubbers, styrene-acrylonitrile-grafted ethylene-propylene-non-conjugated diene rubbers and carboxyl or glycidyl group-modified products of these rubbers or copolymers.

The shaped article thus made and irradiated can then be coated on the irradiated surface with an alkyd-melamine-based or acrylic-urethane-based coating.

The polyphenylene ether resin contained in the composition (I) is a polymer obtained by oxidatively polymerizing at least one phenol compound represented by the following formula:



wherein  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  each represents a hydrogen atom, a halogen atom, a hydrocarbon group, or a substituted hydrocarbon group, provided that at least one of  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  is a hydrogen atom, in oxygen or an oxygen-containing gas in the presence of an oxidative coupling catalyst.

Specific examples of  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  in the above formula include hydrogen, chlorine, bromine, fluorine, iodine, and such groups as methyl, ethyl, n- or isopropyl, n-, iso-, sec- or t-butyl, chloroethyl, hydroxyethyl, phenylethyl, benzyl, hydroxymethyl, carboxyethyl, methoxycarbonyl, cyanoethyl, phenyl, chlorophenyl, methylphenyl, dimethylphenyl, ethylphenyl and allyl.

Specific examples of the phenol compound represented by the above formula include phenol, o-, m-, or p-cresol, 2,6-, 2,5-, 2,4-, or 3,5-dimethylphenol, 2-methyl-6-phenylphenol, 2,6-diphenylphenol, 2,6-diethylphenol, 2-methyl-6-ethylphenol, 2,3,5-, 2,3,6-, or 2,4,6-trimethylphenol, 3-methyl-6-t-butylphenol, thymol and 2-methyl-6-allylphenol. In addition, copolymers of the phenol compounds of the above formula with other phenol compounds, such as polyhydric aromatic compounds, e.g., bisphenol A, tetrabromobisphenol A, resorcin, hydroquinone, or a novolak resin, are also employable.

Preferred examples of the polyphenylene ether resin include a homopolymer of 2,6-dimethylphenol or 2,6-diphenylphenol and a copolymer of 2,6-dimethylphenol as a major component and 3-methyl-6-t-butylphenol or 2,3,6-trimethylphenol as a minor component.

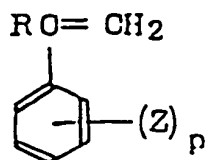
More preferred of these is a 2,6-dimethylphenol homopolymer, i.e., poly(2,6-dimethyl-1,4-phenylene ether).

The oxidative coupling catalyst which can be used in the oxidative polymerization of the phenol compound is not particularly limited, and any catalyst capable of catalyzing this polymerization is usable. Typical examples of such a catalyst include those composed of a cuprous salt and a tertiary amine, e.g., cuprous chloride-triethylamine and cuprous chloride-pyridine; those composed of a cupric salt, an amine, or an alkali metal hydroxide, e.g., cupric chloride-pyridine-potassium hydroxide; those composed of a manganese salt and a primary amine, e.g., manganese chloride-ethanolamine and manganese acetate-ethylenediamine; those composed of manganese salt and an alcoholate or phenolate, e.g., manganese chloride-sodium methylate and manganese chloride-sodium phenolate; and those composed of a cobalt salt and a tertiary amine.

It is known that polyphenylene ether resin obtained by oxidative polymerization has physical properties varying depending on whether the oxidative polymerization is conducted at a temperature higher than 40°C (high temperature polymerization) or at a temperature not higher than 40°C (low temperature polymerization). In the present invention, either high temperature polymerization or low temperature polymerization can be adopted.

The polyphenylene ether component (I) may be a polyphenylene ether resin to which a styrene polymer or other polymer is grafted. Methods for producing such grafted polyphenylene ether resins include a process in which a styrene monomer and/or other polymerizable monomer is graft polymerized in the presence of a polyphenylene ether resin and an organic peroxide, as described, for example, in JP-B-47-47862, JP-B-48-12197, JP-B-49-5623, JP-B-52-38596, and JP-B-52-30991; and a process in which the above-described polyphenylene ether resin, a styrene polymer, and a free radical generator are melt kneaded as described in JP-A-52-142799.

A styrene resin which may be present in composition (I) is generally selected from polymers containing at least 25% by weight of units derived from vinylaromatic monomers such as those represented by the following formula:



wherein R represents hydrogen, a lower alkyl group, e.g., alkyl groups having from 1 to 4 carbon atoms, or a halogen; Z represents hydrogen, a vinyl group, a halogen atom, or a lower alkyl group; and p is 0 or an integer of from 1 to 5. Examples of the styrene resin include homopolymers such as polystyrene, polychlorostyrene, poly( $\alpha$ -methylstyrene), and poly(p-methylstyrene); and styrene-containing copolymers such as styrene-acrylonitrile copolymers, copolymers of ethylvinylbenzene and divinylbenzene, and styrene-acrylonitrile-methylstyrene terpolymers.

Of these, a styrene homopolymer is particularly preferred.

A styrene resin present in the composition can be a rubber-modified polystyrene resin.

The rubber-modified polystyrene resin as referred to in this invention means any of various polystyrene compositions containing a two-phase system consisting of a matrix of the above-described styrene resin and a rubber dispersed therein in the form of separate particles. Such rubber particles can be formed by mechanically blending the polystyrene resin and rubber. Alternatively, the rubber-modified polystyrene may be produced by polymerizing styrene in the presence of a rubber, thereby dispersing the grafted elastomer phase in the resulting polystyrene resin. In this case, the elastomer phase particles contain a styrene polymer sorbed thereby.

Resin (I) according to the present invention may be a mixture of a polyphenylene ether resin and a styrene resin, and in this case, the proportion of the two polymers may be selected freely. In general, the content of the styrene resin in resin (I) and that of the polyphenylene ether resin each preferably is from 20 to 80% by weight based on the total amount of the polyphenylene ether resin and the styrene resin excluding rubber.

The polyamide resin which may be contained in resin (I) according to the present invention is one or more polyamides selected from aliphatic polyamides, thermoplastic aromatic copolyamides, and aromatic nucleus-hydrogenated copolyamides. Specific examples of such polyamides are as follows. The aliphatic polyamides are those which have a molecular weight of about 10,000 or more and may be prepared by linking a saturated aliphatic dicarboxylic acid having from 4 to 12 carbon atoms with an equimolar amount of an aliphatic diamine having from 2 to 12 carbon atoms. In this case, it is possible, if desired, to use the diamine such that terminal amine groups are present in excess relative to terminal carboxyl groups. Conversely, a dibasic acid may be used such that acid groups are present in excess. Likewise, these polyamides may also be satisfactorily produced from the above-described acid and an amine-forming derivative, such as, for example, esters, acid chlorides and amine salts. Representative examples of the aliphatic dicarboxylic acid used to produce the aliphatic polyamide include adipic acid, pimelic acid, azelaic acid, suberic acid, sebacic acid and dodecanedioic acid. On the other hand, representative examples of the aliphatic diamine include hexamethylenediamine and octamethylenediamine. These aliphatic polyamides may also be produced by self-condensation of lactams. Examples of the aliphatic polyamides include polyhexamethylene adipamide (nylon 6.6), polyhexamethylene azelamide (nylon 6.9), polyhexamethylene sebacamide (nylon 6.10), polyhexamethylene dodecanamide (nylon 6.12), poly-bis(p-aminocyclohexyl)methanedodecanamide and polytetramethylene adipamide (nylon 4.6). Examples thereof further include polyamides formed by the ring cleavage of lactams, such as polycaprolactam (nylon 6) and polylauryllactam. Further, polyamides produced by polymerization in which at least two amines or acids selected from those used for producing the above-mentioned polymers are employed, such as, for example, polymers produced from adipic acid, sebacic acid, and hexamethylenediamine. Examples of the aliphatic polyamides furthermore include polyamide blends such as blends of nylon 6.6 and nylon 6 and copolymers such as nylon 6.6/6. Preferred aliphatic polyamides for use in resin (I) include polyhexamethylene adipamide (nylon 6.6), polycaprolactam (nylon 6), and blends of polyhexamethylene adipamide (nylon 6.6) and polycaprolactam (nylon 6).

The thermoplastic aromatic copolyamides are copolyamides containing an aromatic component, such as, for example, polyhexamethylene isophthalamide (nylon 6I). Such thermoplastic copolyamides containing an aromatic component mean melt polymerizable polyamides which contain, as major constituent components, aromatic amino acids and/or aromatic dicarboxylic acids, such as p-aminomethylbenzoic acid, p-aminoethylbenzoic acid, terephthalic acid, and isophthalic acid.

Examples of diamines that can be used as other constituent components in the aromatic polyamides include hexamethylenediamine, undecamethylenediamine, dodecamethylenediamine, 2,2,4- or 2,4,4-trimethylhexamethylenediamine, m-xylylenediamine, p-xylylenediamine, bis(p-aminocyclohexyl)methane, bis(p-aminocyclohexyl)propane, bis(3-methyl-4-aminocyclohexyl)methane, 1,3-bis(aminomethyl)cyclohexane, and 1,4-bis(aminomethyl)cyclohexane. In place

of these diamines, isocyanates may be used. If required, other comonomers may be used without any particular limitation, such as, for example, 4,4'-diphenylmethane diisocyanate and tolylene diisocyanate. Further, lactams,  $\omega$ -amino acids having from 4 to 12 carbon atoms, and compounds derived from an aliphatic dicarboxylic acid having from 4 to 12 carbon atoms and an aliphatic diamine having from 2 to 12 carbon atoms may also be utilized. Examples thereof include such  
 5 lactams and amino acids as  $\epsilon$ -caprolactam,  $\omega$ -laurolactam, 11-aminoundecanoic acid, and 12-aminododecanoic acid, and equimolar salts of various diamines enumerated above with adipic acid, azelaic acid, or sebacic acid.

Representative examples of the thermoplastic aromatic copolyamides comprising the above-mentioned components include a copolyamide of p-aminomethylbenzoic acid and  $\epsilon$ -caprolactam (e.g., nylon AHBA/6); polyamides comprising, as a major component, a 2,2,4- or 2,4,4-trimethylhexamethylenediamine terephthalic acid salt (e.g., nylon THDT,  
 10 nylon THDT/6I); polyamides comprising, as a major component or components, a hexamethylenediamine isophthalic acid salt and/or a hexamethylenediamine terephthalic acid salt and, as a comonomer component or components, a bis(p-aminocyclohexyl)methane isophthalic and/or terephthalic acid salt, a bis(3-methyl-4-aminocyclohexyl)methane isophthalic and/or terephthalic acid salt, or a bis(p-aminocyclohexyl)propane isophthalic and/or terephthalic acid salt (e.g., nylon 6I/PACM I, nylon 6I/DMPACM I, nylon 6I/PACP I, nylon 6I/6T/PACM I/PACM T, nylon 6I/6T/DMPACM  
 15 I/DMPACM T, nylon 6I/6T/PACP I/PACP T); polyamides comprising, as a major component, a hexamethylenediamine isophthalic acid salt or a hexamethylenediamine terephthalic acid salt and, as a comonomer component,  $\epsilon$ -caprolactam, 12-aminododecanoic acid, a hexamethylenediamine adipic acid salt, a bis(p-aminocyclohexyl)methane adipic acid salt, a bis(3-methyl-4-aminocyclohexyl)methane adipic acid salt, or the like (e.g., nylon 6I, nylon 6I/6T, nylon 6I/12, nylon 6T/6, nylon 6T/6.6, nylon 6I/PACM 6, nylon 6I/DMPACM 6); and polyamides comprising, as a major component, a bis(p-aminocyclohexyl)methane isophthalic acid salt or a bis(3-methyl-4-aminocyclohexyl)methane isophthalic acid salt and, as a comonomer component, a hexamethylenediamine dodecanedioic acid salt, 12-aminododecanoic acid, or for example nylon PACM I/612, nylon DMPACM I/12.

The aromatic nucleus-hydrogenated copolyamides mean alicyclic copolyamides obtained from the same ingredients for the above-described aromatic copolyamides except that the terephthalic acid or isophthalic acid used as the acid  
 25 monomer is replaced with cyclohexane-1,4-dicarboxylic acid or cyclohexane-1,3-dicarboxylic acid obtained by nucleus hydrogenation of terephthalic acid and isophthalic acid. Further, nucleus-hydrogenated products obtained by nucleus hydrogenation of diamines and diisocyanates (e.g., 4,4'-diphenylmethane diisocyanate, tolylene diisocyanate) may also be used as the monomer.

Preferred polyamides for use in resin (I) according to the present invention are those having a relative viscosity less  
 30 than 2.5 (as measured at 25°C on a solution of 1 g polyamide in 100 cc of 98% concentrated sulfuric acid as a solvent). The reason for this is that if a polyamide having too high a viscosity (relative viscosity of 2.5 or more) is used to prepare a polyphenylene ether/polyamide composition, and an inorganic filler is incorporated therein, the resulting composition comes to have a high melt viscosity to show poor fluidity at the time of shaping.

The saturated polyester resin which may be contained in resin (I) according to the present invention comprises a  
 35 dicarboxylic acid monomer component, at least 40 mol% of which is a terephthalic acid monomer, and a diol component. Other dicarboxylic acid components than terephthalic acid include aliphatic dicarboxylic acids having from 2 to 20 carbon atoms such as adipic acid, sebacic acid, and dodecanedicarboxylic acid; aromatic dicarboxylic acids such as isophthalic acid and naphthalenedicarboxylic acid; and alicyclic dicarboxylic acids such as cyclohexanedicarboxylic acid. These dicarboxylic acids may be used alone or as a mixture thereof. Examples of the diol component include aliphatic or alicyclic  
 40 glycols such as ethylene glycol, 1,3-propanediol, 1,4-butanediol, 1,6-hexanediol, 1,10-decanediol, and 1,4-cyclohexanediol. These glycols may be used alone or as a mixture thereof.

Of these saturated polyester resins, polybutylene terephthalate and polyethylene terephthalate are particularly effective for producing the effects of the present invention. The saturated polyester resin preferably has an intrinsic viscosity ranging from 0.5 to 3.0 dl/g as measured at 25°C using o-chlorophenol as a solvent. With a saturated polyester resin  
 45 whose intrinsic viscosity is out of this range, the desired mechanical strength can hardly be obtained.

Rubbery substance (II) which is contained in the resin composition to be used for producing the shaped article treated in the present invention can be an elastomer and/or a polyolefin resin having a low flexural modulus and/or a modified rubbery substance.

Specific examples include ethylene-propylene rubbers, ethylene-propylene-non-conjugated diene rubbers, ethylene-butene rubbers, propylene-butene rubbers, isoprene-butylene rubbers, polyisoprene, polybutadiene, styrene-butadiene rubbers, styrene-butadiene-styrene block copolymers, partially hydrogenated styrene-butadiene block copolymers, styrene-isoprene block copolymers, styrene-grafted ethylene-propylene rubbers, styrene-grafted ethylene-propylene-non-conjugated diene rubbers, styrene-acrylonitrile-grafted ethylene-propylene rubbers, styrene-acrylonitrile-grafted ethylene-propylene-non-conjugated diene rubbers, partially hydrogenated styrene-isoprene block copolymers, Thiokol rubbers, polysulfide rubbers, polyurethane rubbers, polyether rubbers (e.g., polypropylene oxide), epichlorohydrin rubbers, polyester elastomers, polyamide elastomers, linear low-density polyethylene, and mixtures thereof.

The modified rubbery substance may be obtained by modifying any of the above-mentioned rubbery substances with a compatibilizer. Examples of modified rubbery substances that can be used as rubbery substance (II) include

maleic anhydride-grafted ethylene-propylene rubbers, maleic anhydride-grafted styrene-butadiene-styrene block copolymers, maleic anhydride-grafted partially hydrogenated styrene-butadiene block copolymers, maleic anhydride-grafted partially hydrogenated styrene-isoprene block copolymers, and glycidyl methacrylate-grafted ethylene-propylene rubbers.

5 Examples of modified rubbery substances that can be used as rubbery substance (II) further include those in which compatibilizers have been copolymerized, such as ethylene-acrylate-maleic anhydride copolymers, ethylene-acrylate-glycidyl methacrylate copolymers, ethylene-vinyl acetate-glycidyl methacrylate copolymers, and blends thereof.

10 Particularly preferred rubbery substances are ethylene-propylene rubbers, ethylene-propylene-non-conjugated diene rubbers, styrene-butadiene block copolymers, partially hydrogenated styrene-butadiene block copolymers, styrene-isoprene block copolymers, partially hydrogenated styrene-isoprene block copolymers, styrene-grafted ethylene-propylene rubbers, styrene-acrylonitrile-grafted ethylene-propylene rubbers, styrene-grafted ethylene-propylene-non-conjugated diene rubbers, styrene-acrylonitrile-grafted ethylene-propylene-non-conjugated diene rubbers, carboxyl or glycidyl group-modified products of these rubbers or copolymers, linear low-density polyethylene having a density in the range of from 0.885 to 0.935 g/cm<sup>3</sup>, preferably from 0.885 to 0.925 g/cm<sup>3</sup>, ethylene-methyl acrylate-maleic anhydride copolymers, ethylene-ethyl acrylate-maleic anhydride copolymers, ethylene-vinyl acetate-glycidyl methacrylate copolymers, ethylene-methyl acrylate-glycidyl methacrylate copolymers, and mixtures thereof.

15 The compatibilizer (IV) which is contained in the resin composition to be used for producing the shaped article treated in the present invention is selected from maleic anhydride, maleic acid, fumaric acid, itaconic acid, glycidyl acrylate, glycidyl methacrylate and allyl glycidyl ether.

20 Examples of inorganic filler (III) which can be contained in the resin composition to be used for producing the shaped article treated in the present invention include talc (magnesium silicate), clay (aluminum silicate), zinc oxide, titanium oxide and calcium carbonate, with talc being preferred. The inorganic filler preferably has an average particle diameter of 5.0  $\mu$ m or less, and more preferably has such an average particle diameter of 5.0  $\mu$ m or less and an aspect ratio of 5 or more. While the inorganic filler may be used in an untreated state, it can be used after being surface treated with 25 any of various silane coupling agents, titanium coupling agents, higher fatty acids, higher fatty acid esters, higher fatty acid amides, higher fatty acid salts, or other surface active agents for the purpose of improving interfacial adhesion to the polyphenylene ether resin and nylon resin and/or saturated polyester resin or for the purpose of improving dispersibility.

30 Glass fibers can be used either alone or in combination with the inorganic filler. In order to improve interfacial adhesion to the polyphenylene ether resin and/or the polyamide resin and/or saturated polyester resin and to improve dispersibility, glass fibers can be used in combination with any of various coupling agents generally including silane coupling agents and titanium coupling agents.

The proportion of each component of the resin composition to be used for producing the shaped article treated in the present invention is as follows.

35 In resin (I), the blend ratio of a polyphenylene ether resin, a mixture of a polyphenylene ether resin and a styrene resin, or a graft copolymer of a polyphenylene ether resin and styrene to the polyamide and/or saturated polyester resin is from 5:95 to 100:0 by weight, preferably from 5:95 to 95:5 by weight. If the blend ratio is outside the range, the desired effects of the present invention cannot be obtained. More preferably, the blend ratio is from 30:70 to 70:30 by weight.

40 The amount of rubbery substance (II) incorporated in the resin composition is up to 50 parts by weight per 100 parts by weight of resin (I) comprising a polyphenylene ether-based resin and at least one thermoplastic resin selected from a polyamide resin and a saturated polyester resin. In the case where the resin composition contains no rubbery substance, the composition has improved heat resistance, rigidity, and dimensional stability, although its impact resistance is not so good. Rubbery substance amounts exceeding 50 parts by weight are not preferred because the resulting compositions have significantly impaired heat resistance. The more preferred range of the amount of rubbery substance 45 (II) incorporated is up to 30 parts by weight.

The amount of compatibilizer (IV) incorporated in the resin composition is up to 10 parts by weight per 100 parts by weight of resin (I). If the amount of compatibilizer (IV) exceeds 10 parts by weight, the appearance is poor.

50 The amount of inorganic filler and/or glass fibers (III) incorporated in the resin composition is from 0 to 50 parts by weight per 100 parts by weight of resin (I). In the case where the resin composition contains neither inorganic filler nor glass fibers, the composition has improved impact resistance, although its heat resistance, rigidity, and dimensional stability are not so good. If component (III), an inorganic filler and/or glass fibers, are incorporated in an amount exceeding 50 parts by weight, the resulting composition has significantly impaired impact resistance. The preferred range of the amount of component (III) is from 0 to 30 parts by weight. In the case where an inorganic filler and glass fibers are used in combination, the ratio of the amount of the former to that of the latter may be in the range of from 20:80 to 80:20 by 55 weight.

If desired, the thermoplastic resin composition to be used for producing the shaped article treated in the present invention may further contain pigments, ultraviolet absorbers, heat stabilizers, flame retardants, antioxidants, and plasticizers.

Methods for blending component (I-1) which is a polyphenylene ether resin, a mixture of a polyphenylene ether resin and a styrene resin, or a graft copolymer of a polyphenylene ether resin and styrene, component (I-2) which is at least one thermoplastic resin selected from polyamide resins and saturated polyester resins, rubbery substance (II), inorganic filler (III-1), glass fibers (III-2), and compatibilizer (IV) to prepare the resin composition to be used for producing the shaped article treated in the present invention are not particularly limited, and known melt kneading techniques may be used. Employable melt kneading devices include an extruder, a kneader, rolls, and the like, with an extruder being particularly preferred. The order of incorporating each component during melt kneading is not particularly limited. That is, any of the following methods may be used: a method in which components (I-1), (I-2), (II), (III-1) and/or (III-2), and (IV) are introduced into the melt kneading device at a time and melt kneaded simultaneously; a method in which components (I-1) and (IV) are melt kneaded beforehand in the presence or absence of a free radical initiator, and components (I-2), (II), and (III-1) and/or (III-2) are then added thereto and melt kneaded together; a method in which components (I-1), (II), and (IV) are melt kneaded beforehand in the presence or absence of a free radical initiator, and components (I-2) and (III-1) and/or (III-2) are then added thereto and melt kneaded together; a method in which components (I-1), (II), (IV), and (III-1) and/or (III-2) are melt kneaded beforehand in the presence or absence of a free radical initiator, and component (I-2) is then added thereto and melt kneaded together; a method in which components (I-1), (II), and (IV) are melt kneaded beforehand, subsequently component (I-2) is added thereto and kneaded together, and then components (III-1) and/or (III-2) is added thereto and melt kneaded together; and other similar methods.

The kneaded resin composition may be shaped by various shaping techniques including injection molding and extrusion.

The surface treating method and coating method of the present invention are explained below.

In the present invention, a surface of the thermoplastic resin shaped article is irradiated with ultraviolet light.

This shaped article may have any of various forms such as films, plates or fibers.

The light with which the surface is irradiated is a light having a wavelength of 300 nm or less, and particularly is an ultraviolet light containing rays having wavelengths of 254 nm and 185 nm as main working wavelengths. Higher intensities are preferred.

Although there is no need, in this invention, of degreasing the surface of the thermoplastic resin shaped article with e.g. a solvent before irradiation with ultraviolet light, degreasing may be conducted in an ordinary known manner.

Suitable degreasing agents which can be used to degrease the surface of the shaped article include water, aqueous solutions of alkalis and alcohols, e.g., ethanol and isopropyl alcohol.

Methods for bringing the degreasing agent into contact with the surface of the shaped article including coating, wiping and spraying. Degreasing may also be accomplished by power washing with an aqueous solution, e.g. of an acid or an alkali.

The irradiation with ultraviolet light conducted in the present invention is preferably conducted for a period of from 20 seconds to 10 minutes, more preferably from 30 seconds to 5 minutes. If the irradiation time is shorter than 20 seconds, sufficient improvements in the coating suitability, adhesion properties, and printability of the resin shaped article may not be obtained. An irradiation time longer than 10 minutes may be not only uneconomical but cause deterioration of the resin surface, producing an adverse effect.

According to the present invention, the thus irradiated shaped article may be coated with an alkyd-melamine coating or an acrylic-urethane coating.

The present invention is now illustrated in greater detail with reference to the following Examples and Comparative Examples, but it should be understood that the present invention is not deemed to be limited thereto. In the Examples and Comparative Examples, all parts are by weight.

#### I. Raw materials used in Examples and Comparative Examples:

The following polyphenylene ether, saturated polyester resin, high-impact polystyrene, and modified rubbery substance were used in addition to a commercially available unmodified rubbery substance and polyamide.

##### (1) Polyphenylene ether (hereinafter referred to as "PPE"):

The PPE used is one obtained by dissolving 2,6-dimethylphenol in a mixture of toluene and methanol, adding manganese chloride-ethylenediamine thereto, and then conducting oxidative polymerization in an oxygen atmosphere at a temperature of 30°C.

##### (2) Saturated polyester resin:

Polybutylene terephthalate; Tufpet PBT® N1200, manufactured by Mitsubishi Rayon Co., Ltd.

## (3) High-impact polystyrene:

High-impact polystyrene having a butadiene rubber content of 8.6 wt% was used.

## 5 (4) Modified rubbery substance:

A maleic anhydride-grafted ethylene-propylene rubber (MAH-EPR) obtained as follows was used.

10 An ethylene-propylene rubber ("Sumitomo Esprene® E120P", manufactured by Sumitomo Chemical Company, Limited) was mixed beforehand with maleic anhydride and t-butyl peroxydodecanoate. This mixture was fed to an extruder having a screw diameter of 30 mm and an L/D ratio of 28 and having a barrel temperature of 230°C, and reaction of the rubber with maleic anhydride was conducted in the extruder at a screw revolution number of 60 rpm. Strands of the modified rubber discharged from a die were cooled with water and then pelletized.

The grafted amount of maleic anhydride was 1.5 wt% based on the amount of the rubber.

15 II. Evaluation of coating suitability:

Coating suitability of shaped articles were evaluated in terms of the initial adhesion strength of a coating as follows.

20 The surface of the shaped article sample was coated with a coating, and the coating layer was crosshatched with a razor blade so as to make 100 (10 x 10) 2-mm squares. A 24 mm-wide adhesive tape ("Cello Tape®" produced by Nichiban Company, Limited) was applied to the crosshatched coating layer surface by pressing it with a finger, and then the tape was stripped at a stretch by forcibly pulling one end of the tape. The number of squares remaining after the tape stripping was counted to obtain a retention (%), which indicated the initial adhesion strength of the coating.

EXAMPLE 1

25

50 Parts of PPE, 10 parts of maleic anhydride-grafted ethylene-propylene rubber (MAH-EPR) as a rubbery substance, and 0.4 part of maleic anhydride were fed to a continuous twin-screw extruder ("TEM-50", manufactured by Toshiba Machine Co., Ltd.) from a first hopper, while 50 parts of a polyamide ("Unitika Nylon® A1030BRL", produced by Unitika Ltd.) was fed to the extruder by means of a constant-delivery feeder from a second hopper provided between the first hopper and a vent hole. These ingredients were melt kneaded at a cylinder temperature of 260°C and a screw revolution number of 380 rpm, and then granulated. Using the thus-obtained granules, a molded article in a plate form was prepared by means of an injection molding machine ("IS-150E", manufactured by Toshiba Machine Co., Ltd.).

35 The molded article was placed in front of an ultraviolet light-irradiating apparatus equipped with a low-mercury vapor pressure lamp (made of synthetic quartz, 200 W), with the distance between the light source and the molded article surface being about 15 cm. Surface treatment was then conducted by irradiating the surface with an ultraviolet light having main acting wavelengths of 254 nm and 185 nm in an air atmosphere for 120 seconds.

40 The irradiated surface was then coated with an alkyd-melamine coating ("Luga Bake®", manufactured by Kansai Paint Co., Ltd.). This was done by applying the coating twice, followed by baking at 140°C for 40 minutes. The initial adhesion strength of the coating was measured, and the results obtained are shown in Table 1 given later.

EXAMPLE 2

45 The same procedures as in Example 1 were repeated except that the surface of the molded article was degreased with isopropyl alcohol and that ultraviolet light-irradiating time was changed to 60 seconds. The initial adhesion strength of the coating is shown in Table 1.

COMPARATIVE EXAMPLE 1

50 The same procedures as in Example 1 were repeated except that the ultraviolet light irradiation was omitted. The initial adhesion strength of the coating is shown in Table 1.

COMPARATIVE EXAMPLE 2

55 The same procedures as in Example 2 were repeated except that the ultraviolet light irradiation was omitted. The initial adhesion strength of the coating is shown in Table 1.

**EXAMPLE 3**

The same procedures as in Example 2 were repeated except that a styrene-butadiene-styrene block copolymer rubber (SBS; "Clayton® TR 1102", manufactured by Shell Chemical Co., Ltd.) was used as a rubbery substance. The initial adhesion strength of the coating is shown in Table 1.

**COMPARATIVE EXAMPLE 3**

The same procedures as in Example 3 were repeated except that the ultraviolet light irradiation was omitted. The initial adhesion strength of the coating is shown in Table 1.

**EXAMPLE 4**

The same procedures as in Example 2 were repeated except that 15 parts of magnesium silicate (talc; "MW5000S", manufactured by Hayashi Kasei Co. Ltd.) was fed from the first hopper as an inorganic filler. The initial adhesion strength of the coating is shown in Table 1.

**COMPARATIVE EXAMPLE 4**

The same procedures as in Example 4 were repeated except that the ultraviolet light irradiation was omitted. The initial adhesion strength of the coating is shown in Table 1.

**EXAMPLE 5**

The same procedures as in Example 1 were repeated except that the coating used in Example 1 was replaced with an acrylic-urethane coating ("Origiplat ZNY", manufactured by Origin Electric Co., Ltd.) and that baking was conducted at 80°C for 30 minutes. The initial adhesion strength of the coating is shown in Table 2.

**COMPARATIVE EXAMPLE 5**

The same procedures as in Example 5 were repeated except that the ultraviolet light irradiation was omitted. The initial adhesion strength of the coating is shown in Table 2.

TABLE 1

	PPE	Composition (parts)			Filler	Pre-treatment	Initial Initial Adhesion Strength of Coating (%)
		Polyamide Resin	Compatibilizer	Rubbery Substance (%)			
Example 1	50	50	0.4	MAH-EPR 10	-	none	100
Example 2	50	50	0.4	MAH-EPR 10	-	IPA wiping	100
Example 3	50	50	0.4	SBS 10	-	IPA wiping	100
Example 4	50	50	0.4	MAH-EPR 10	talc 15	IPA wiping	100
Comparative Example 1	50	50	0.4	MAH-EPR 10	-	none	0
Comparative Example 2	50	50	0.4	MAH-EPR 10	-	IPA wiping	0
Comparative Example 3	50	50	0.4	SBS 10	-	IPA wiping	0
Comparative Example 4	50	50	0.4	MAH-EPR 10	talc 15	IPA wiping	0

TABLE 2

	PPE	Composition (parts)			Pre-treatment	Initial Adhesion Strength of Coating (%)
		Polyamide Resin	Compatibilizer	Rubbery Sub- stance		
Example 5	50	50	0.4	MAH-EPR 10	none	100
Comparative Example 5	50	50	0.4	MAH-EPR 10	none	85

**EXAMPLE 6**

45 parts of PPE, 55 parts of polybutylene terephthalate, 1.6 parts of maleic anhydride, 2 parts of styrene, and 1 part of 1,3-bis(t-butylperoxyisopropyl)benzene ("Sanperox® TY1.3, manufactured by Sanken Chemical Industrial Co., Ltd.) as a free radical initiator were melt kneaded in a continuous twin-screw extruder ("TEM-50", manufactured by Toshiba Machine Co., Ltd.) at a cylinder temperature of 280°C and a screw revolution number of 300 rpm, and the resulting blend was granulated. Thus, a resin composition was prepared.

To 100 parts of the thus-obtained resin composition was added 5 parts of phenol-blocked diphenylmethane diisocyanate. This mixture was melt kneaded in a 40-mmφ single-screw extruder (manufactured by Tanabe Plastics Co., Ltd.) at a cylinder temperature of 280°C and a screw revolution number of 90 rpm, and then granulated. The thus-obtained pellets were molded into a plate form by means of an injection molding machine ("IS-150E", manufactured by Toshiba Machine Co., Ltd.).

The molded article was placed in front of an ultraviolet light-irradiating apparatus equipped with a low-mercury vapor pressure lamp (made of synthetic quartz, 200 W), with the distance between the light source and the molded article surface being about 10 cm. Surface treatment was then conducted by irradiating the surface with an ultraviolet light having main acting wavelengths of 254 nm and 185 nm in an air atmosphere for 60 seconds.

The irradiated surface was then spray coated with acrylic-urethane coating R271 (manufactured by Nippon Bee Chemical Co., Ltd.), and the coating applied was baked and dried at 90°C for 30 minutes. The initial adhesion strength of the coating was measured. As a result, the retention was 100%, showing good initial adhesion.

**COMPARATIVE EXAMPLE 6**

The same procedures as in Example 6 were repeated except that the ultraviolet light irradiation was omitted. The initial adhesion strength of the coating was measured and, as a result, the retention was 80%.

**Claims**

1. A method of surface treating a shaped article made of a thermoplastic resin, which comprises irradiating a surface of the shaped article with ultraviolet light having a wavelength of 300 nm or less, said shaped article being obtained from a resin composition comprising by weight, (I) from 5 to 100% of a polyphenylene ether, a mixture of a polyphenylene ether and a styrene polymer, or a graft copolymer of a polyphenylene ether and styrene and from 95 to 0% of at least one polyamide and/or saturated polyester, and per 100 parts by weight of composition (I); a rubbery substance (II) in an amount of up to 50 parts; (III) 0 to 50 parts of an inorganic filler and/or glass fibers; and at least one compatibilizer (IV) in an amount of up to 10 parts, said compatibilizer selected from maleic anhydride, maleic acid, fumaric acid, itaconic acid, glycidyl acrylate, glycidyl methacrylate and allyl glycidyl ether, and said rubbery substance (II) being one or more polymers selected from ethylene-propylene rubbers, ethylene-propylene-non-conjugated diene rubbers, styrene-butadiene block copolymers, partially hydrogenated styrene-butadiene block copolymers, styrene-isoprene block copolymers, partially hydrogenated styrene-isoprene block copolymers, styrene-grafted ethylene-propylene rubbers, styrene-acrylonitrile-grafted ethylene-propylene rubbers, styrene-grafted ethylene-propylene-non-conjugated diene rubbers, styrene-acrylonitrile-grafted ethylene-propylene-non-conjugated diene rubbers and carboxyl or glycidyl group-modified products of these rubbers or copolymers.

2. A method as claimed in Claim 1, wherein said polyphenylene ether is poly(2,6-dimethyl-1,4-phenylene ether).
3. A method as claimed in either Claim 1 or 2, wherein said styrene is a styrene homopolymer or a rubber-modified polystyrene.
- 5 4. A method as claimed in Claim 1, 2 or 3, wherein said polyamide is polycaprolactam.
5. A method as claimed in Claim 1, 2 or 3, wherein said polyamide is polyhexamethylene adipamide.
- 10 6. A method as claimed in Claim 1, 2 or 3, wherein said polyamide is one or more aliphatic polyamides, thermoplastic aromatic copolyamides or aromatic nucleus-hydrogenated copolyamide.
7. A method as claimed in any preceding claim, wherein the time of the irradiation is 20 seconds to 10 minutes.
- 15 8. A method as claimed in any preceding claim, wherein the irradiated light includes 185 and 254 nm as main wavelengths.
9. A method as claimed in any preceding claim, wherein the surface of the article is degreased before the irradiation.
- 20 10. A method as claimed in any preceding claim, wherein the irradiated shaped article is then coated on the irradiated surface with an alkyd-melamine coating or an acrylic-urethane coating.

#### Patentansprüche

- 25 1. Verfahren zur Oberflächenbehandlung eines aus einem thermoplastischen Harz hergestellten Formkörpers, umfassend das Bestrahlen einer Oberfläche des Formkörpers mit ultraviolettem Licht mit einer Wellenlänge von 300 nm oder Weniger, wobei der Formkörper aus einer Harzzusammensetzung erhalten wird, die, auf das Gewicht bezogen, (I) 5 bis 100 % eines Polyphenylenethers, eines Gemisches eines Polyphenylenethers und eines Styrolpolymers oder eines Pfcopolymeren eines Polyphenylenethers und Styrol und 95 bis 0 % mindestens eines Polyamids und/oder gesättigten Polyesters; und pro 100 Gew. -Teile der Zusammensetzung (I) eine kautschukartige Substanz (II) in einer Menge bis zu 50 Teilen; (III) 0 bis 50 Teile eines anorganischen Füllstoffs und/oder Glasfasern; und mindestens einen Verträglichkeitsverbesserer (IV) in einer Menge von bis zu 10 Teilen umfaßt, wobei der Verträglichkeitsverbesserer ausgewählt ist aus Maleinsäureanhydrid, Maleinsäure, Fumarsäure, Itaconsäure, Acrylsäureglycidylester, Methacrylsäureglycidylester und Allylglycidylether, und die kautschukartige Substanz (II) ein oder mehrere Polymere ist, ausgewählt aus Ethylen-Propylen-Kautschuken, Kautschuken aus Ethylen, Propylen und nicht konjugiertem Dien, Styrol-Butadien-Blockcopolymeren, teilweise hydrierten Blockcopolymeren aus Styrol und Butadien, Styrol-Isopren-Blockcopolymeren, teilweise hydrierten Blockcopolymeren aus Styrol und Isopren, mit Styrol gepfropften Kautschuken aus Ethylen und Propylen, mit Styrol und Acrylnitril gepfropften Kautschuken aus Ethylen und Propylen, mit Styrol gepfropften Kautschuken aus Ethylen, Propylen und nicht konjugiertem Dien, mit Styrol und Acrylnitril gepfropften Kautschuken aus Ethylen und nicht konjugiertem Dien und mit Carboxyl- oder Glycidylgruppen modifizierten Produkten dieser Kautschuke oder Copolymere.
- 30 2. Verfahren nach Anspruch 1, wobei der Polyphenylenether Poly(2,6-dimethyl-1,4-phenylenether) ist.
- 35 3. Verfahren nach entweder Anspruch 1 oder 2, wobei das Styrol ein Styrolhomopolymer oder ein kautschukmodifiziertes Polystyrol ist.
4. Verfahren nach Anspruch 1, 2 oder 3, wobei das Polyamid Polycaprolactam ist.
- 50 5. Verfahren nach Anspruch 1, 2 oder 3, wobei das Polyamid Polyhexamethylenadipinsäureamid ist.
6. Verfahren nach Anspruch 1, 2 oder 3, wobei das Polyamid ein oder mehrere aliphatische Polyamide, thermoplastische aromatische Copolyamide oder ein aromatisches kernhydriertes Copolyamid ist.
- 55 7. Verfahren nach einem der vorstehenden Ansprüche, wobei die Bestrahlungsdauer 20 Sekunden bis 10 Minuten beträgt.
8. Verfahren nach einem der vorstehenden Ansprüche, wobei das Bestrahlungslicht 185 und 254 nm als Hauptwellenlängen umfaßt.

9. Verfahren nach einem der vorstehenden Ansprüche, wobei die Oberfläche des Artikels vor der Bestrahlung entfettet wird.
10. Verfahren nach einem der vorstehenden Ansprüche, wobei der bestrahlte Formkörper dann auf der bestrahlten Oberfläche mit einer Alkyd-Melamin-Beschichtung oder einer Acryl-Urethan-Beschichtung beschichtet wird.

# Revendications

1. Méthode de traitement de la surface d'un article façonné fait en résine thermoplastique, qui comprend l'irradiation d'une surface de l'article façonné par un rayonnement ultraviolet ayant des longueurs d'onde égales ou inférieures à 300 nm, ledit article façonné étant obtenu à partir d'une composition de résine comprenant en masse, (I) de 5 à 100 % d'un éther de polyphénylène, d'un mélange d'un éther de polyphénylène et d'un polymère styrénique, ou d'un copolymère greffé d'un éther de polyphénylène et de styrène et de 95 à 0 % d'au moins un polyamide et / ou d'un polyester saturé, et pour 100 parties en masse de la composition (I) ; une substance élastomère (II) en une quantité allant jusqu'à 50 parties ; (III) 0 à 50 parties d'une charge minérale et/ou de fibres de verre et au moins un agent assurant la compatibilité (IV) dans une quantité allant jusqu'à 10 parties, ledit agent assurant la compatibilité étant choisi parmi l'anhydride maléique, l'acide maléique, l'acide fumarique, l'acide itaconique, l'acrylate de glycidyle, le méthacrylate de glycidyle et l'éther allylglycidyle, et ladite substance élastomère (II) étant un ou plusieurs polymères choisis parmi les caoutchoucs éthylène-propylène, les caoutchoucs éthylène-propylène-diène non conjugué, les copolymères séquencés styrène-butadiène, les copolymères séquencés styrène-butadiène partiellement hydrogénés, les copolymères séquencés styrène-isoprène, les copolymères séquencés styrène-isoprène partiellement hydrogénés, les caoutchoucs éthylène-propylène greffés au styrène, les caoutchoucs éthylène-propylène greffés au styrène-acrylonitrile, les caoutchoucs éthylène-propylène-diène non conjugué greffés au styrène, les caoutchoucs éthylène-propylène-diène non conjugué greffés au styrène-acrylonitrile et les produits de ces caoutchoucs ou copolymères modifiés par des groupes carboxyle ou glycidyle.
2. Méthode selon la revendication 1, dans laquelle l'éther de polyphénylène est l'éther de poly(2,6-diméthyl-1,4-phénylène).
3. Méthode selon la revendication 1 ou 2, dans laquelle ledit styrène est un homopolymère du styrène ou un polystyrène modifié par un caoutchouc.
4. Méthode selon la revendication 1, 2 ou 3, dans laquelle ledit polyamide est le polycaprolactame.
5. Méthode selon la revendication 1, 2 ou 3, dans laquelle ledit polyamide est le polyhexaméthylène adipamide.
6. Méthode selon la revendication 1, 2 ou 3, dans laquelle ledit polyamide est un ou plusieurs polyamides aliphatiques, copolyamides aromatiques thermoplastiques ou copolyamide aromatique à cycle hydrogéné.
7. Méthode selon une quelconque des revendications qui précèdent, dans laquelle la durée de l'irradiation est située entre 20 secondes et 10 minutes.
8. Méthode selon une quelconque des revendications qui précèdent, dans laquelle le rayonnement irradié comprend en tant que longueurs d'onde principales les longueurs d'onde 185 et 254 nm.
9. Méthode selon une quelconque des revendications qui précèdent, dans laquelle la surface de l'article est dégraissée avant l'irradiation.
10. Méthode selon une quelconque des revendications qui précèdent, dans laquelle l'article façonné irradié est ensuite revêtu, sur sa surface irradiée, par un revêtement alkyde-mélatamine ou par un revêtement acrylique-uréthane.